Prevalence of Blood-Borne Pathogens in an Urban, University-Based General Surgical Practice

Eric S. Weiss, MD, Martin A. Makary, MD, MPH,*†‡ Theresa Wang, BS,* Dora Syin, BS,* Peter J. Pronovost, MD, PhD,*†‡ David Chang, PhD, MPH, MBA,* and Edward E. Cornwell III, MD*†*

Objective: To measure the current prevalence of blood-borne pathogens in an urban, university-based, general surgical practice.

Summary Background Data: Human immunodeficiency virus (HIV), hepatitis B, and hepatitis C represent significant occupational hazards to the surgeon. While the incidence of these blood-borne pathogens is increasing in the general population, little is known about the current prevalence of these exposures among patients presenting for surgery.

Methods: We studied 709 consecutive operative cases (July 2003 to June 2004) in a university practice that provides all inpatient, emergency department, and outpatient consultative general surgical services. Trauma cases and bedside procedures were excluded. Data collected included HIV, hepatitis B and C test results, type of operation, age, sex, and history of intravenous drug use.

Results: Testing for blood-borne pathogens was performed in 53% ($N = 373$) of 709 patients based on abnormal liver function tests, neutropenia, history of IV drug use, or patient request. Thirty-eight percent of all operations (142/373) were found to involve a blood-borne pathogen when tested: HIV (26%), hepatitis B (4%), hepatitis C (35%), and coinfection with HIV and hepatitis C (17%). Forty-seven percent of men tested positive for at least 1 blood-borne pathogen. Seventy-three different types of operations were performed, ranging from Whipple procedures to amputations. Soft-tissue abscess procedures 48% (34/71) and lymph node biopsies 67% (10/15) ($P < 0.01$) were most often associated with blood-borne pathogens. Infections were more common among men ($P < 0.01$), patients 41 to 50 years of age ($P < 0.01$), and patients with a history of intravenous drug use ($P < 0.01$).

Conclusions: HIV and hepatitis C infections are common in an urban university general surgical practice, while hepatitis B is less common. In addition, certain operations are associated with significantly increased exposure rates. Given the high incidence of these infections, strategies such as sharpless surgical techniques should be evaluated and implemented to protect surgeons from blood-borne pathogens.

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Approximately 500,000 percutaneous blood exposures occur among hospital-based healthcare workers in the United States each year.[1] Surgeons and operating room personnel have the highest risk of occupational exposure,[2–5] and sharp injuries in the operating room are the least likely to be reported.[6] While the exposure rate associated with the operating room setting is recognized to be significant, little is known about the current prevalence rates of human immunodeficiency virus (HIV), hepatitis B, and hepatitis C among patients presenting for surgery.

It is currently estimated that approximately 2% of all Americans are infected with the hepatitis C virus alone,[7] with approximately 80% of these individuals having no signs or symptoms of disease. Similarly, HIV carriers are living longer with the advent of improved antiviral therapies, while concurrent public health interventions have had little impact on behavior modification and overall transmission rates. Consequently, there is an increasing number of individuals with blood-borne pathogens in the general population and an associated increase in occupational health hazards to healthcare providers.

Although the prevalence of blood-borne pathogens has been studied in the general population, estimates are lacking in surgical patients. Because physiologic and social factors of HIV and hepatitis are associated with an increased risk for developing a surgical problem, the prevalence of these infections may be higher in surgical patients than in the general

From the *Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, Maryland; †Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland; and the ‡Johns Hopkins Patient Safety and Quality Research Group, Johns Hopkins Medical Institutions, Baltimore, Maryland.

Reprints: Martin A. Makary, MD, MPH, Assistant Professor of Surgery, Health Policy and Management, Johns Hopkins University School of Medicine, Johns Hopkins Medical Institutions, Building A-5, 4940 Eastern Ave, Baltimore, MD 21224. E-mail: mmakary1@jhmi.edu.

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population. Physiologic risk factors include hepatic dysfunction, renal impairment, associated malignancies, and an immunocompromised state. Social risk factors for surgical problems include intravenous drug use (IVDU), unsafe sex, and poor access to medical care. The collective result is a significant number of operations associated with the manifestations or sequelae of a blood-borne pathogen infection, namely, abscess drainage, lymph-node biopsy, skin cancer excision, abdominal exploration, transplantation, and other operations with similar complications from these procedures. Thus, given the increased likelihood that an infected individual will require surgery, it may be inaccurate to base estimates of blood-borne pathogen incidence during surgery on the known estimates in the general population or other disease-specific groups. Therefore, the specific aim of this study was to estimate the prevalence of HIV, hepatitis B, and hepatitis C encountered in the operating room based on our general surgical practice in an urban, university-based hospital.

MATERIALS AND METHODS

Patient Population and Study Design

This was a retrospective investigation of the prevalence of blood-borne pathogens in a general surgical population at a university hospital. Participants were identified through emergency room and inpatient surgical consultations and through an outpatient clinic, which serves the urban East Baltimore community and receives national and international referrals. This collective population of patients comprises the William Stewart Halsted surgical service at the Johns Hopkins Hospital. Operations performed within this practice included a wide spectrum of cases, ranging from elective Whipple operations to simple abscess drainage procedures. Trauma patients were excluded because of a low rate of testing in this group. Bedside procedures were also excluded. While HIV and hepatitis in the setting of bedside procedures is an important subject, we chose to focus this study on blood-borne pathogens encountered by operating room personnel in the operating room.

Primary Outcome Variables

The primary outcome variables were the prevalence of HIV, hepatitis B, and hepatitis C infections in our study population. Medical records were reviewed to identify test results for HIV, hepatitis B, and hepatitis C, as well as basic patient characteristics. Patients were considered to be HIV-positive if they had a positive test result with enzyme-linked immunosorbent assay (Biorad Inc, Redmond, WA), Western blot analysis (Biorad Inc), or detection of HIV RNA via polymerase chain reaction (PCR) (Roche Diagnostics, Branchburg, NJ). Patients were considered to be hepatitis C positive if they had either a positive test result for the presence of antibody by serologic testing (Abbott Laboratories Inc, Abbott Park, IL) or if they had confirmation of the presence of HCV RNA via reverse transcription PCR. Patients were considered hepatitis B positive if they had the presence of hepatitis B surface or core antigen in their serum (Abbott Laboratories Inc). Patients who had a positive surface antibody test result without a demonstrated antigen were recognized to have either cleared a previous infection or to have been vaccinated against hepatitis B. Indications for testing included work-related exposures, suspicion of disease by history (ie, a history of IV drug use), clinical examination (dermatologic signs of drug abuse), laboratory abnormalities (ie, abnormal liver function tests or neutropenia), or patient request. Additional data collected included age, race, gender, history of IVDU or tobacco abuse, history of positive toxicology screening for illegal substances, and the presence of a documented psychiatric disorder. Type of operation, defined by CPT code, was collected. All test results were performed at the Johns Hopkins Hospital Immunology and HIV testing laboratory.

Statistical Analysis

Prevalence of blood-borne pathogens is expressed as the number of cases with a positive test result divided by the total number of cases tested. Comparisons of prevalence rates by patient characteristics was performed using χ^2 testing (or Fisher exact test when appropriate) with SPSS 8.0 (SPSS Inc, Chicago, IL). For all statistical analysis, a P value of less than 0.05 was considered significant.

RESULTS

We identified 709 consecutive operations in this practice over a 1-year period (July 2003 to June 2004); 53% were performed on males (Table 1). A total of 73 different types of operations were performed in the specified year, demonstrat-

TABLE 1. Patient Demographics

Operations (n)	709
Operations on Men	334 (47%)
Operations on African Americans	435 (61%)
Operations on Whites	252 (36%)
Operations on Hispanics	7 (1%)
Operations on Asians	7 (1%)
Operations on Others	8 (1%)
Mean age of patients (years)	51
Number of different operations performed	73
Number of patients tested for HIV	285 (40%)
Number of patients tested for hepatitis B	294 (41%)
Number of patients tested for hepatitis C	296 (42%)
Positive history of smoking	88 (12%)
Positive history of IV drug use	76 (11%)

TABLE 2. Prevalence of HIV, Hepatitis B, and Hepatitis C Among Patients Tested

	HIV (n = 284)	Hepatitis B (n = 304)	Hepatitis C (n = 296)	HIV and Hepatitis C (n = 221)	Any pathogen present (n = 373)
Males	45/142 (32%)*	6/150 (4%)	65/163 (40%)*	22/123 (18%)	88/187 (47%)*
Females	30/142 (21%)	6/154 (4%)	38/133 (29%)	16/98 (16%)	53/186 (29%)
Total Tested	75/284 (26%)	12/304 (4%)	103/296 (35%)	38/221 (17%)	141/373 (38%)

*$p < 0.05$.

ing the broad case mix within this practice. Mean age of the population was 51 years. African Americans comprised 61% of patients and whites 36% ($P < 0.05$). When asked about IVDU, 76 patients (11%) reported past or present IVDU, and 200 (28%) reported no drug use (drug history was not available for the remaining 433 patients). Testing for at least 1 of the 3 blood-borne pathogens was performed in 53% (n = 373) of the 709 operations.

A history of IVDU was a strong risk factor for infections. Indeed, of the 76 patients who admitted to IVDU, 43% had HIV, 8% had hepatitis B, and 65% had hepatitis C. The increased risk ratio of having an infection with a history of IVDU compared with those denying a history of IVDU was 6, 4, and 7, respectively ($P < 0.01$).

Of the 709 patient operations, 40% were tested for HIV, 41% for hepatitis B, and 42% for hepatitis. Among the 373 patients tested for blood-borne pathogens, 26% were positive for HIV, 4% for hepatitis B, and 35% for hepatitis C (Table 2). Men were more likely than women to be infected, 47% versus 29%, respectively. The highest prevalence among all subgroups was men testing positive for hepatitis C (40%). African American patients were more likely than white patients to have HIV (20% versus 4%, $P < 0.05$) and hepatitis C (25% versus 8%, $P < 0.05$). There was a relatively low prevalence of hepatitis B overall (4% for both men and women). Only 51 out of 294 patients (17%) tested positive for hepatitis B surface antibody alone, indicating either a cleared infection or a previous vaccination.

By age group, the highest prevalence of both HIV and hepatitis C occurred in 41- to 50-year-olds ($P < 0.01$), although these pathogens were deemed common among patients 31 to 60 years of age as well (Fig. 1). In general, there was a trend for HIV rates in younger patients (21–60 years) and higher rates of hepatitis C in older patients (31–80 years). Hepatitis B infection rates were comparatively low. For all 3 blood-borne pathogens, a very low prevalence was observed at the early and later stages of life, with no infections noted in patient ages 0 to 20 years and 81 to 100 years.

The 11 most common operative cases performed are outlined in Figure 2. HIV and hepatitis C were more prevalent in patients undergoing lymph-node biopsies and soft-tissue procedures than those undergoing the other 9 operations ($P < 0.01$) (Fig. 2). Specifically, a blood-borne pathogen was encountered in 71% of all soft-tissue abscess procedures (34/48) and 67% of all lymph-node biopsies (10/15) By contrast, certain procedures such as those involving laparoscopic approaches were associated with very low rates of blood-borne pathogens.

DISCUSSION

Previous data have suggested that exposure to blood-borne pathogens is an occupational risk for health care

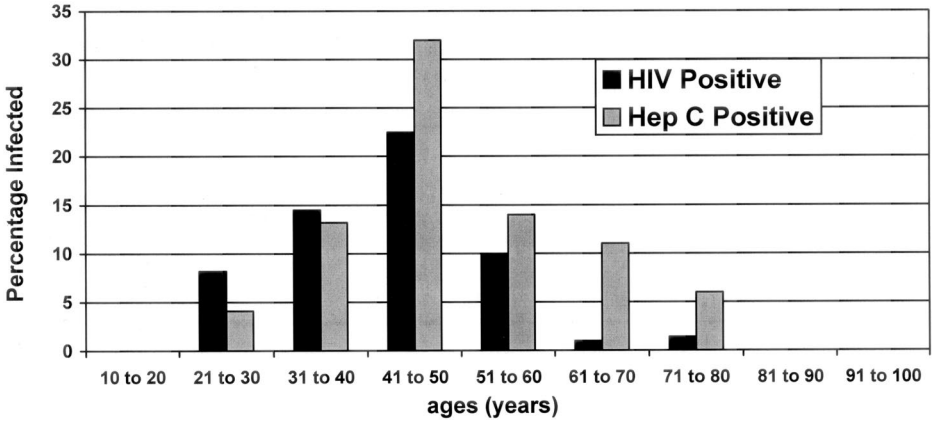

FIGURE 1. Percentage of patients with HIV and hepatitis C by age group.

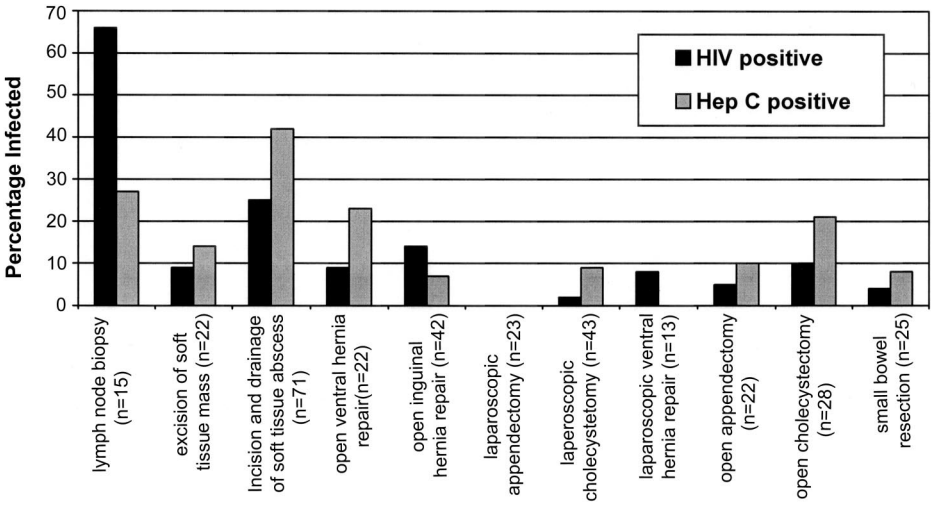

FIGURE 2. Percentage of patients with HIV and hepatitis C for the 11 most common operations.

workers,[8–12] with surgeons having a higher rate of percutaneous exposure than other specialists.[5,13] In this study of adult general surgical patients in an urban academic medical center, we found a much higher prevalence of blood-borne pathogens than previously estimated.[8–12,14] Indeed, 38% of all operations involved a blood-borne pathogen, and almost half (47%) of all men tested positive for at least 1 infection. Moreover, infection with a blood-borne pathogen was present in up to 65% of patients with a history of IVDU and as many as 71% of patients undergoing specific types of operations, such as soft-tissue abscess procedures and lymph-node biopsies.

Based on survey data, injuries have been estimated to occur in approximately 7% of operations,[3,4] and as many as 87% of surgeons are estimated to experience a percutaneous injury at some point in their career.[5] Prior studies addressing exposure risk have focused on nonsurgical patients or patients limited to an elective practice. For example, a study of elective surgical patients at Johns Hopkins found only a 0.4% HIV infection rate.[14] However, this and many other reported studies[13] were conducted when the incidence of blood-borne pathogens in the general population were significantly lower.

Our study shows a significant risk for surgeons operating in an urban university setting that is greater than previously reported. While our patient population represents an urban general surgical practice that is skewed toward the confounding factors of low socioeconomic status and increased substance abuse, many urban university-based hospitals serve a similar patient population. In fact, most of United States university hospitals are located in urban areas, with many serving similar populations. Irrespective of the population base, the risk of high exposure is real, with these rates relevant for many health providers at some point in their careers, either in training or in practice.

The increased prevalence of blood-borne pathogens identified in this study also has important implications for surgical educators and directors of surgical programs. Most concerning about our findings was the distribution of blood-borne pathogens by type of operation. Operations associated with the greatest risk of infection are lymph-node biopsy, soft-tissue-mass excision, and abscess-drainage cases, commonly assigned to the most inexperienced surgeons-in-training. This association emphasizes the need to provide education regarding safe operating room practices early in the training process.

There are limitations in the data presented in this study. Determination of patients to test was based on suspicion of disease that was not standardized for all providers involved in the care of patients. Thus, there is likely a selection bias in the population tested. Nevertheless, even if all nontested patients were negative, infection rates found would still be alarming (20%) and higher than previously published. In addition, appropriate consent for HIV testing limited study of the HIV infection. A larger research study may help determine a more accurate prevalence rate for patients who present to a surgical practice stratified by presentation and circumstances.

Recording patient's history of IV drug use does appear to be an important predictor of blood-borne pathogen infection. In our study alone, patients reporting past or present IVDU were associated with an alarmingly high rate of HIV (43%) and hepatitis C (65%). Given the high prevalence rate within this group, HIV and hepatitis testing should be performed in all patients with an IV drug use history.

A unique aspect of this study is the finding that patients undergoing different operative procedures have different rates of blood-borne pathogens. Such information may help surgeons stratify risk and implement preventive strategies accordingly. For example, knowledge of the close cor-

relation between a lymph-node biopsy procedure or IV drug use and the presence of a blood-borne pathogen may be the impetus for implementing a protocol to exercise extreme caution when handling sharps, as well as increase sedation or anesthesia to minimize inadvertent movement of the patient during a procedure. Universal precautions are a vital part of any comprehensive occupational safety program and should not be understated. Compliance with universal precautions is clearly an important first step toward a safer work environment for all operating room personnel. At the same time, it is our belief that while traditional strategies for minimizing sharp injuries are essential, they have not decreased the rate of occupational injuries in the operating room. As an additional safety measure, we suggest performing operations without the use of sharps whenever possible. Such candidate cases for this technique include opening soft-tissue abscesses using a cutting current of the electrocautery; using skin staples or glue instead of subcuticular stitching; stapling instead of sewing bowel when possible; and employing surgical clips instead of stitches when feasible to achieve an equal result. We have found that many basic general surgical operations, which are often staffed with the most inexperienced house staff, can be successfully performed using a completely sharpless technique. Indeed, these basic general surgical cases we speak of were those with the highest rate of HIV and hepatitis seen in our study. Thus, sharpless surgery performed in combination with traditional precautions may help to significantly reduce occupational exposure risks for certain candidate operations.

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Discussions

DR. L. D. BRITT (NORFOLK, VIRGINIA): With HIV and hepatitis both being an omnipresent threat to many health care providers, especially those in the surgical arena, this study is extremely important, and I commend the authors for an outstanding investigation. I just have a few questions.

The objective or aim of your study was to measure the current prevalence of blood-borne pathogens in an urban, university-based, general surgical practice. Why were bedside procedures (an increasing component of operative cases, especially in tertiary hospitals) excluded? Is this not considered a potentially hazardous setting?

With "universal precaution" being so strongly advocated in all health care settings where there is direct patient contact, what additional implementation would you recommend outside of "universal precaution"?

I guess you predicted my final question. I was going to ask you about selection bias. But I think you told me that was one of your limitations.

DR. MARTIN A. CROCE (MEMPHIS, TENNESSEE): The authors have attempted to define the prevalence of hepatitis B and C and HIV in this urban, university-based, surgical service, and then interestingly stratified their disease prevalence by operation. And they state that the prevalence of these diseases is much higher than the previous reports.

Does that mean that these diseases are much more prevalent in Baltimore than other major cities? Probably not. The higher incidence rates are likely due to patient selection, since about half the operated patients were tested. That leads to my first question. And I echo what Dr. Britt said.

Since the objective was to estimate the prevalence of these diseases, why exclude both trauma patients and, more specifically, the bedside procedures? It was interesting that the little vignette that was shown actually included a bedside procedure. These patients are clearly integral in the training programs and arguably represent the greatest opportunity for occupational exposure.

Relative to the various questions, it is not surprising that HIV was associated with lymph-node biopsy. What is not obvious is the association between HIV and inguinal herniorrhaphy or the link between hepatitis C and ventral hernia repair. I was wondering if you could please comment on that.

Finally, I think the important message of this study is that blood-borne pathogens are everywhere. There are bears behind every corner and they must be assumed to be in all patients. Appropriate precautions are mandatory and should be an integral part of resident training. As the author suggests, technology advantages regarding sharpless surgery can reduce the risk.

I would like to commend the authors for this study. By presenting this study, they are trying to avoid the ostrich phenomenon. They are trying to take our heads out of the sand for this very important problem. Recognizing this problem is only part, it is just the beginning of solving it. And I look forward to future studies from them relative to solutions of this most perplexing problem facing us.

Dr. Lewis M. Flint, Jr. (Tampa, Florida): One of the things that I learned from spending 6 years on the American College of Surgeons Governors Committee on Blood-Borne Pathogens was that it is time for us to stop describing the problem and start describing the solution. I would like to point out a couple of things about Dr. Cornwell's presentation that describe the problem in graphic detail in addition to what he showed us with his data.

More than 10 years ago now, a study from the Johns Hopkins Medical Institutions Emergency Department showed that the prevalence of HIV positivity in an unselected group of patients was 18%. And yet in that TV clip, which I think occurred about 3 years ago, you saw that nobody in the room was practicing universal precautions. Nobody.

You have described part of the problem; let's start describing the solution. What do you do specifically to make your associates, your nurses, your colleagues on the faculty, and your residents, and your medical students aware of what this problem is and aware of what they can do to protect themselves?

Do you demand that residents practice universal precautions during trauma resuscitation, and do you demand that the trauma faculty present practice universal precautions? Do you demand that your residents, and do you, double glove in the operating room? Do you wear eye protection at all times with all procedures in all patient encounters? Can we make this a universal policy in all of the hospitals where we are? Should we ask the joint commission that accredits hospitals state that if there is a certain level of noncompliance with universal precautions you get a categorical deficiency when you are visited by the JCAHO? What can we do to stop the problem?

Fortunately for us, there are fewer than 5 surgeons worldwide who have converted from negativity to positivity for HIV. So HIV is not the real problem for surgeons. But hepatitis C is. We don't have a treatment for hepatitis C, and it is sometimes, many times, a career-ending event.

So we have got to find the solution to the problem. And I would submit that the solution is at hand: universal precautions, double gloving, and in certain selected cases, I would very much agree that blunt needles and using cautery instead of scalpel can be helpful in protecting us and our colleagues from these infections.

Dr. Raleigh R. White, IV (Temple, Texas): When the HIV issue came forward almost 20 years ago now, in our institution there was a short time period when there was a great deal of interest in universal testing for all surgical patients. That process required us to get a specific permission from each of those patients prior to the testing. My question has to do with that permission. Has this disease, you might say, come of age to the point where that is no longer an issue? Is it a problem to do testing on large numbers of patients like this without specifically asking them if it is okay to do it? Do you have any information on that?

Dr. Richard J. Howard (Gainesville, Florida): I would like to make some comments to reiterate what other discussants have said. We have had universal precautions now suggested as guidelines by the CDC since August of 1987. They have no enforcement power, but we all know OSHA made them mandatory. Yet despite that we are still in this morass of some surgeons suggesting that we test individuals. We don't have to test anyone. The whole message of the CDC is to regard everyone as if they are infected with HIV, hepatitis B, hepatitis C, or who knows what other virus. You treat everybody the same, as if they are infected.

So we shouldn't have any special precautions. We should use maximal prevention for every patient. Some patients may be infected and not test positive. With trauma patients, you can't test them because the test takes too long and they may be in the operating room before the test results are back.

Just to emphasize what Dr. Flint suggested, there have been 2 studies that I know of of universal precautions, one in Miami and we did one ourselves. The title of the Miami paper was "Universal Precautions Are Universally Ignored." They did theirs in the emergency room, where more likely there was blood exposure with a patient where there had been gunshot wounds or stab wounds; they were less likely to adhere to universal precautions. We did ours in the operating room and in the wards. And I am ashamed to say that our adherence to universal precautions was very low as well. We still have a long way to go.

DR. MARTIN A. MAKARY (BALTIMORE, MARYLAND): I would like to thank Dr. Britt, Dr. Croce, Dr. Flint and the other discussants for raising some excellent points.

Certainly, it takes time to change a culture. Many surgeons have long suspected that blood-borne pathogens pose a significant occupational risk within our profession. In fact, we all recognize that the risk of contracting a blood-borne pathogen is part of the job. The purpose of this study specifically was to focus on measuring that exposure risk based on our experience providing general surgical services to the local community. We chose to focus on the operating room as one particular area where we encounter that risk, among several areas. Bedside procedures represent another important setting, which deserves similar study.

Baltimore ranks among the U.S. cities with the highest rates of HIV and hepatitis in the country, with AIDS being the leading cause of death among young adults in Baltimore between the ages of 25 and 44 years. The high prevalence rate may reflect the socioeconomic status within the city limits, as well as the high rate of IV drug abuse, particularly in the East Baltimore community we serve. To this day, still 40% of all cases of hepatitis C have an unknown mode of transmission, and it is suspected that IV drug abuse is the driving vector.

We chose to exclude trauma patients to focus on infection as an independent risk factor for surgical disease; specifically, a risk factor for presenting to the operating room. Trauma patients may also represent a unique group with a different infection rate. Furthermore, we found in our review, that very few trauma patients are routinely tested. We are currently engaged in a study to test trauma patients during their hospitalization as a possible strategy for early public health intervention. This effort is aimed at both describing the incidence of infection in this population, as well as identifying a window for disease-specific treatment and counseling. It is our hope that routine screening of patients in our practice may help minimize unknowing propagation of HIV and hepatitis within the community by untested carriers.

The descriptive association noted between inguinal hernia repair and HIV and ventral hernia repair and hepatitis may represent variance inherent to the sample size or the preferred referral patterns to our general surgery clinic, which offers laparoscopic inguinal and ventral hernia repairs in select patients.

In reference to universal precautions, we do insist that our residents comply, even in emergent situations. A change in surgical culture toward an appreciation of the occupational risks involved takes time and, historically, a culture change is best made by role models taking the lead rather than imposing policy mandates on health providers. It is our hope that this data will further promote increased awareness and safer practices among our surgeons-in-training.

Over the last several years, there have been few innovations developed to minimize percutaneous injuries in the operating room. We have recently begun using a practical method to prevent percutaneous injuries by performing certain select operations without knives or needles—that is, a sharpless surgical technique. We have performed appendectomies, lymph node biopsies, and other common operations using a protocol which reserves the use of a sharp for instances when a substitute sharpless technique is unable to provide the same outcome. The cutting current of the electrocautery, tissue staplers, laparoscopy, and skin glue are some of the sharpless techniques used. These strategies can be ideal for patients with risk factors for blood-borne pathogens since infections requiring an operations are more common in this population and are more technically amenable to a sharpless technique (soft tissue and abscess drainage procedures). These cases are often staffed by the most junior and inexperienced residents who, ironically, already have an increased risk for percutaneous injury because they often lack the appropriate sharp handling skills. We have also performed trauma and non-trauma laparotomies without sharps in cases where the abdomen needed to be left open. This was done with the cautery for the skin incision, tissue staplers for a bowel resection, and a ligasure for division of the mesentery. This approach is used to minimize percutaneous exposures in an emergency setting—a setting where needlestick injuries are known to be common.

It is estimated that there are about 40,000 new cases of HIV in the United States each year, and in about 25% of these cases, according to the CDC, the individual doesn't even know that they have HIV. Hepatitis C is increasing at an even faster rate, with an unknown future trajectory. HIV consent is still required by law in most states prior to testing, however, in cases where a health professional is stuck, it is possible to obtain a needlestick panel test without informed consent. Patients can be offered the information if they agree to formal pre-test counseling.

It is our hope that while we reinforce existing safe practices of sharp handling and universal precautions in the operating room, there will be new innovation for better strategies such as sharpless surgery, blunt-tip needles, improved shielding, and other stronger barriers to infection. Ultimately, these developments will be refined in a way which minimizes our occupational risk in surgery and, at the same time, does not limit our ability to perform effectively.